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in order to compare them with those of Delaunay. Only one difference was found which seemed to indicate an error when estimation was made for remainders in Delaunay's results, and this difference was precisely where it might have been expected, namely, in the part of the coefficient of sin $(2D-l)$, which is of the form $e^3f(m)$. The part of this coefficient, which is of the form $ee'^2f(m)$, is not carried sufficiently far in Delaunay's theory to notice any difference, as the series in powers of m converges very slowly. The part of the form $e^3f(m)$ in my theory contributes $-1''\cdot23$; in Delaunay's theory it is $-1''\cdot13$, or, when estimation is made for the remainder, $-1''\cdot07$. These small differences in the values of the coefficients of the periodic terms are, of course, not very important practically, but the comparison furnishes a valuable test of the accuracy of the various calculations, and in this respect there is no cause for dissatisfaction.

The terms of the fourth order are now nearing completion, and, so far as the various tests have been able to be applied, appear to fulfil the degree of accuracy which was aimed at. They have demanded more extended calculations than the terms of any other order have required or will require. Circumstances prevent them going forward very rapidly at present; but it is hoped that they may be ready for publication within the next twelve months.

Haverford College, Pa.:
1899 *November* 3.

On the proper Motions of Berlin B, Nos. 5072 *and* 5073.

By F. A. Bellamy.

In the comparison of Plate 1415, taken at the University Observatory, Oxford, for the *Astrographic Catalogue* in 1899, R.A. $14^h\ 20^m$, $+25°$, with stars in the *Astronomische Gesellschaft* Catalogues of Cambridge and Berlin, a large discordance was noticed between the Oxford measures and two stars Nos. 5072 and 5073 in the Berlin B Catalogue.

Failing to find any notification of an error or discordance in the *Bonn Durchmusterung* or Berlin B Catalogue, or any proper motions from the usual sources of information, we were fortunate to find that another plate of this region had been taken in 1893, but rejected through insufficient number of stars.

For comparison of this plate with 1415 four stars were selected and the measured co-ordinates compared. The linear corrections for reducing plate 399 to 1415 were found to be

$$+\cdot0083x+\cdot0013y-\cdot177 \text{ to } x.$$
$$-\cdot0013x+\cdot0083y-\cdot046 \text{ to } y.$$

To show how quickly two plates may be compared, the actual figures are given below (in reseau intervals).

					Berlin 5075	5072	5073.
Plate 399 x	14·788	12·585	23·106	1·774	16·187	15·781	15·632
$-ax$	−·122	−·104	−·192	−·015	−·134	−·131	−·130
$-by$	−·003	−·033	−·016	−·020	−·002	−·003	−·003
$-c$	+·177	+·177	+·177	+·177	+·177	+·177	+·177
	14·840	12·625	23.075	1·916	16·228	15·824	15·676
Plate 1415 x	14·840	12·627	23·074	1·915	16·229	15·844	15·696
$x_{399}-x_{1115}$	−·000	−·002	+·001	+·001	−·001	−·020	−·020
Plate 399 y	2·413	25·193	12·440	15·506	1·697	2·093	2·051
$-dx$	+·019	+·016	+·030	+·002	+·021	+·020	+·020
$-ey$	−·020	−·209	−·103	−·129	−·014	−·017	−·017
$-f$	+·046	+·046	+·046	+·046	+·046	+·046	+·046
	2·458	25·046	12·413	15·425	1·750	2·142	2·100
Plate 1415 y	2·456	25·048	12·413	15·426	1·755	2·115	2·076
$y_{399}-y_{1415}$	+·002	−·002	·000	−·001	−·005	+·027	+·024

The differences for the two stars B 5072 and 5073 between the Oxford plates, which were exposed at epochs 1893·342 and 1899·400, are large, and undoubtedly due to proper motions which seem common to the two stars. From these differences annual Proper Motions of +0ˢ·070 in R.A. and −1″·26 in Dec. were deduced ; though the difference of epochs is only six years, these values may be very near the truth, as they depend solely on measures from two photographic plates, and not on meridian observations.

Using these proper motions, and carrying back the Oxford measures to the epoch of Berlin, we get the following comparison :—

Berlin B. 5072	Epoch 1880·9.	Oxf.—Berl. −0ˢ·07 and +0″·9
Berlin B. 5073	Epoch 1881·1.	Oxf.—Berl. −0·04 „ +0·6

The region which includes these two stars has also been photographed at the Paris Observatory ; and in the Report for 1895, page 18, the plate, 954, is mentioned as having been measured.

The positions for the two stars for 1900·0 from Oxford measures are

		h	m	s	°	′	″
Berlin B.	5072	14	21	5·40	+24	5	55·2
	5073	14	21	8·59	+24	6	7·5

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I have not been successful in finding any observations of these two stars as a double star, probably the wide distance causing them to escape notice; moreover they are both fainter than the 9th magnitude, and possibly 5073 is slightly variable, as it is not given in B.D.—though noted as 9·1 at Berlin—unless only the brighter of the two was purposely observed. But their large common proper motion seems to show that they are physically connected. The stars deserve to have some observations made for magnitude, motion in space or about each other, and for parallax.

During the course of work for the *Astrographic Catalogue* at the University Observatory, Oxford, many occasions have arisen when plates taken in the earlier years have been of great use in checking, if not in determining, proper motions.

Had the zones +25°, +27°, +29°, +31°, been systematically photographed in the earlier period of the work, and the intermediate or overlapping zones, +26°, +28°, +30°, been left till the later years, we should have had at Oxford a difference of epoch of not less than five years, quite sufficient to, at least, verify proper motions. This, however, has not been done here; but, as early plates, rejected through want of stars, often become valuable for this purpose, it may be useful to bear this in mind at those observatories where the plates have not yet been taken. Dr. Gill's proposal in a recent report * to take all the plates over again for measurement seems an excellent one.

University Observatory, Oxford:
1899 *November* 22.

Since writing the above paper I have recollected that the late Radcliffe observer, Mr. E. J. Stone, published a paper † on a case somewhat analogous to this. The paper refers to the proper motions of four stars in the southern hemisphere, ζ *Toucani*, ζ^1 and ζ^2 *Reticuli*, and ϵ *Eridani*. From his discussion Mr. Stone concluded that the four stars have a common proper motion of more than 1″, also that each star is moving away from every other star in the group, being at one time near to each other. The four stars are widely separated in N.P.D., being 2½°, 4′, 19½° ! respectively; and in R.A. ζ *Toucani* is 3^h ! from the other stars, giving an angular distance of 33° !

As these four stars fall in zones photographed for the *Astrographic Catalogue* at the Cape of Good Hope and Melbourne Observatories, it is hoped that they will not be neglected, but a further discussion be made with recent material.

November 24.

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* *Monthly Notices*, lix. p. 247.
† *Monthly Notices*, xl. p. 26.

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New Nebulæ discovered photographically with the Crossley Reflector of the Lick Observatory. By James E. Keeler, D.Sc.

In a recent number of the *Monthly Notices* (vol. lix. p. 537) I printed a list of seven small nebulæ found on plates which had been exposed to the nebula *Messier* 51 with the Crossley reflector. At that time I considered this a rather remarkable number of nebulæ to be found on a plate covering only about one square degree, but more recent experience has shown that as many new nebulæ may generally be found on photographs taken with the Crossley reflector, and sometimes a much larger number. Thus, on a plate exposed for four hours, on November 6, to the nebula H V. 19 *Andromedæ*, there are thirty-one new nebulæ and nebulous stars; on a photograph of H I. 53 *Pegasi*, twenty; and there are nearly as many on several other plates. Besides these new nebulæ, the existence of which has been verified by independent photographs, the plates contain a considerable number of objects which are probably nebulæ so small that the resolving power of the telescope is insufficient to define them in their real form and to bring out their true character. They appear as star-discs which are less dense than true star-discs having the same diameter.

With exposures of four hours the Crossley photographs show stars and nebulæ far beyond the range of any visual telescope, though there are hundreds, if not thousands, of unrecorded nebulæ within reach of our 36-inch refractor. On the assumption that there are three new nebulæ in each square degree (a number which is much below the average for the photographs I have already taken), the number of new nebulæ in the whole sky would be about 120,000. Doubtless there are large regions where few, if any, new nebulæ are to be found; still, I am disposed to regard the above estimate as below the truth.

It is a remarkable and highly significant fact that most of the nebulæ photographed with the Crossley reflector seem to be spirals. In various cases known nebulæ have already been shown to have a spiral form by other observers. The Crossley photographs have shown that many other known nebulæ have the same structure; while in the case of a large proportion of the new nebulæ I have mentioned, a spiral form is either directly recognisable, or is rendered highly probable by the fact that the nebulæ have the same appearance as well-known spirals when photographed with a small instrument. We may perhaps regard the spiral form as that which is normally assumed by a compact isolated nebulous mass, and the exceptions (of which there are many) to somewhat unusual conditions—possibly, in part, to the absence of any definite moment of rotation for the aggregate of the particles constituting the nebula.

Lick Observatory, University of California:
1899 *November* 15.